

## On the system of Phyllophorinæ with descriptions of the species found in Japan.

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*With Plate I and 7 textfigures.*

Having discovered in the Holothurian material at my disposal a number of specimens referable to the interesting species *Pseudocucumis japonicus* (BELL), my attention was directed to the comparative study of tentaculation in the so-called "polychirotous" Cucumarids. In the present paper will be given my views concerning the system of the group, arrived at from my studies, to be followed with descriptions of the species found in the Japanese waters.

### I. On Tentaculation and its Bearing on the System of Cucumariidæ.

#### 1. Observations.

##### i. *Pseudocucumis africanus* (SEMPER).

A goodly number of specimens belonging to this species stood at my disposal, so that my observations on tentaculation were made chiefly on it.

In regard to number, size and arrangement of tentacles in this species, records have been given by LUDWIG [24, p. 1237, Taf. XV., Fig. 16; 26, p. 96, Fig. 11], BEDFORD [4, p. 844, figs. III, B—E] and MITSUKURI [32, textfig. 52]. According to these authors, the two small tentacles, situated in a pair in the midventral radius, are either equal to each other in size and stand side by side, or are of different sizes, in which case the smaller is situated at a position

inner to the larger. With regard to this point I have examined thirty-seven individuals, in all which the arrangement of tentacles, with their well protruded oral parts, could be easily made out. Of them there were found only two individuals which showed a mid-ventral pair of small tentacles of about equal size, standing side by side. One of these individuals was abnormal in that it possessed an extra tentacle, making in all twenty-one tentacles. In all the remaining thirty-five specimens, I have invariably found the tentacles regularly arranged in a way which differed from the statements of the three authors mentioned above.

Of the twenty tentacles they possess, ten are large, five medium-sized, and the remaining five small. Each pair of the large tentacles (textfig. 1,  $D_1$ ,  $V_1$ ,  $R_1$  and  $L_1$ ) is interradian in position and alternates with a pair which consists of a medium-sized ( $D_2$  or  $R_2$ ) and a small ( $V_2$  or  $L_2$ ) tentacle. In the paired lateral radii the small tentacle ( $V_2$ ) stands always ventral to the medium-sized ( $D_2$ ), while in the mid-ventral radius the small one ( $L_2$ ) is situated to the left of a medium-sized ( $R_2$ ). This agrees with ÖSTERGREN's description of his *Pseudocucumis mixta* [33, p. 135. and 36, p. 3], excepting the fact that in my specimens the five small tentacles form an inner circle to the remaining fifteen.

As to the position of the anterior notch in each radial segment of the calcareous ring of the species, SEMPER [42, p. 53] remarked that it is situated "auf einer Seite" in each of the paired radial segments, but in the midventral segment so as to divide this into two equal halves. But for my specimens of *Ps. africanus* I have found ÖSTERGREN's statements as regards the anterior notches in his *Ps. mixta* [36, p. 5] to hold true in essential points. The anterior end of each radial segment of the calcareous ring is divided by a deep notch, through which the radial canal and nerve pass, into two unequal halves, one broader than the other (textfig. 4). Again, each of the two halves has on its anterior margin a slight incision or

notch corresponding to the canals of the smaller tentacles. In the paired radial segments the broader half is always dorsal to the narrower. The unpaired midventral radial segment is congruent in form with the segments of the right side, that is to say, the broader half of it lies to the right of the narrower (textfig. 1).

The manner of branching of tentacular canals, as made out from serial sections through pharyngeal mass of several specimens, seems to be as follows:—

Each radial canal, or the "main canal" as THÉEL has called it [45, p. 135], gives off alternately four tentacular canals (textfig. 1). The first tentacular canal branches out dorsad in paired radii, and to the right in the midventral radius. The second arises on the opposite side at a point just slightly anterior to the point where the first is given off, directed ventrad in paired radii but to the left in the midventral radius. These two canals run nearly transversely, and approaching the margin of radial segments, open each into an expanded part of the tentacular canal by a narrow orifice guarded by the ventilative apparatus or "semilunar valves" in a manner similar to that described for *Cucumaria planci* (BRANDT) by HÉROUARD [15, pp. 580—583]. That expanded part of the canals communicates with the large tentacles ( $D_1$ ,  $V_1$ ,  $R_1$  and  $L_1$ ), and is interposed between a radial segment and an adjoining interradiar segment. The third branch, which is smaller than the two preceding and supplies the medium-sized tentacles ( $D_2$  and  $R_2$ ), leaves the radial canal a short distance anterior to the point where the second canal branches out. In paired radii this stands dorsal to, and in the midventral radius to the right of, the respective radial canal. The fourth, which is the smallest of the four branches, is given off a very short distance from the third branch on the opposite side. This supplies the smallest tentacles forming the inner circle ( $V_2$  and  $L_2$ ). The third and the fourth branches run forwards, each with the ventilative apparatus in its course, over the incisions in the anterior margin of

radial segments. Exceptionally there seems to exist cases in which the branches are given off in a way different from that described above, and that especially with regard to the first and the second branches.

ii. *Phyllophorus japonicus* (v. MARENZELLER), *Ph. fragilis*, sp. n., and *Orcula hypsipyrge* v. MARENZELLER.

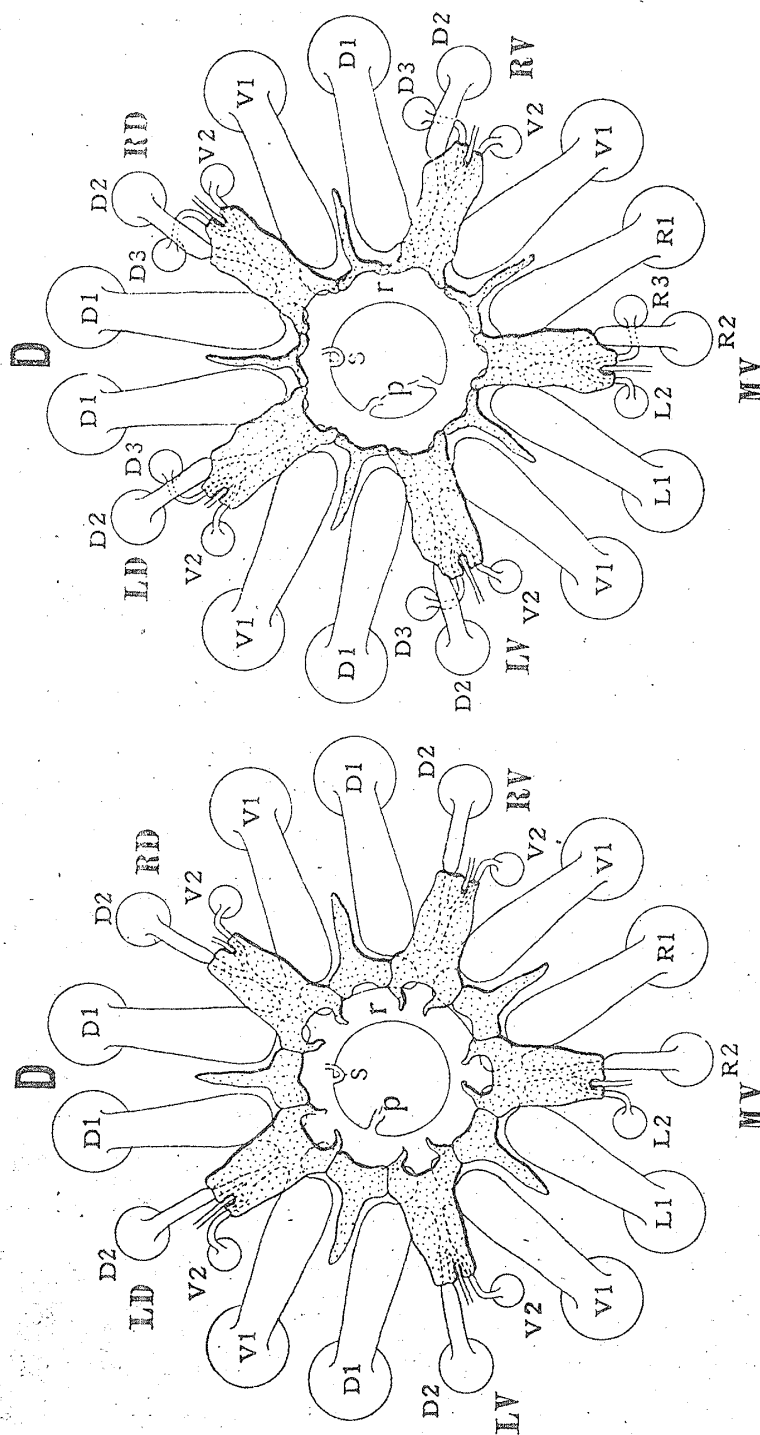
All these three species have twenty tentacles, which agree well with same of *Pseudocucumis africanus* in size and arrangement. In them, as in *Ps. mixta*, the radial segments of calcareous ring show on the axial surface slight depressions corresponding to the course of tentacular canals. The branching of these canals takes place in closely similar way as in *Ps. africanus*, so that a detailed description seems unnecessary. Only it may be noted that in *Ph. japonicus* the anterior margin of each radial calcareous segment is divided into two halves which are subequal or slightly unequal in breadth (textfig. 5, a).

iii. *Pseudocucumis japonicus* (BELL).

Of this species BEDFORD [4, p. 844, figs. II, A—B] has given diagrams showing size and arrangement of tentacles in the two original specimens. Should the blank spaces in his figure II, A—the one in the midventral and the other in the left ventral radius—be filled up each with a large tentacle, that figure will be made to greatly resemble the diagram I have given below (textfig. 2).

Of the several specimens of the species examined by me, all had twenty-five tentacles, except a single abnormal case with twenty-six of them. The large tentacles, ten in number, are disposed interradially in five pairs (textfig. 2,  $D_1$ ,  $V_1$ ,  $R_1$  and  $L_1$ ), with which alternate singly standing medium-sized tentacles numbering five in all ( $D_2$  and  $R_2$ ). The remaining ten small tentacles are arranged in five radially situated pairs ( $V_2$ ,  $D_3$ ,  $L_2$  and  $R_3$ ), forming an inner circle to that of the other fifteen. The only difference from the previous cases of species with twenty tentacles, lies in the addition of five small

Textfig. 2.



Textfig. 1.

Diagram showing the canal system of tentacles and calcaeous ring in *Pseudocumia africana* (fig. 1) and *P. japonica* (fig. 2). Calcaeous ring (dotted) is cut open and arranged radially. One looks at the ring from behind anteriorly, so that the radial canals (outlined with broken lines) are hidden behind radial segments of calcaeous ring. Tentacles represented in relative size and position. Ventilative apparatus in tentacular canals not represented. *D* middorsal interradius; *LD* left dorsal, *LV* left ventral, *RD* right dorsal, *RV* right ventral, *MV* midventral radii, *p* Polian vesicle, *r* circular canal, *s* stone-canal.

tentacles ( $D_3$ ,  $R_3$ ) to the inner circle, a new small tentacle appearing close to each of the five medium-sized ones, in paired radii dorsally to, and in the midventral radius to the right of, the old small tentacle ( $V_2$  or  $L_2$ ).

The anterior part of radial calcareous segments shows some features different from those of the preceding species. A deep indentation divides the anterior edge into two unequal or asymmetrical halves much as in *Ps. africanus* (textfig. 2). The two halves have obliquely slanting edge and each of them shows a slight notch. On the larger half, close to the deep median indentation, there is again another small notch (textfig. 3, a).

It can be plainly made out from sections that each tentacle is supplied with the five tentacular canals branching from the radial canal in an alternate arrangement. Aside from the presence of a fifth distalmost branch in each radius, the tentacular canals arise in a way similar to that in the twenty-tentacled species mentioned above. The small distalmost branch, which communicates with the fifth small tentacle, arises, in paired radii dorsally from, and in midventral radius to the right of, each radial canal. The smallest notch on the larger half of the divided margin of each radial calcareous segment stands in relation with the small distalmost tentacular canal just referred to (textfig. 2,  $D_3$  and  $R_3$ ).

## 2. Observations on previous records regarding tentaculation.

The size and arrangement of tentacles in *Pseudocucumis acicula* (SEMPER), *Ps. africanus*, *Ps. japonicus*, *Phyllophorus dearmatus* DENDY & HINDLE and *Ph. holothurioides* LUDWIG have been diagrammatically figured by previous authors, as LUDWIG [20, Taf. VI., Figg. 17, 23; 24, Taf. XV., Fig. 16; and 26, p. 96, Figg. 11, 12], BEDFORD [4, p. 844, figs. I—III], and DENDY & HINDLE [9, p. 104, fig. A]. But none of them have given an account of the

internal organization with reference to the arrangement of tentacles.

As to the relation between the notches of radial calcareous segments and tentacular canals, SEMPER [42, p. 67] has stated for his *Thyonidium cebuense* (= *Phyllophorus cebuensis*) as follows:—, „Den Zwischenräumen zwischen den radialen und interradialen Gliedern entsprechen die grossen Tentakel, die kleineren stehen auf kleinen Einschnitten der radialen Glieder, welche einen 3. Ausschnitt für das Radiärgefäss und den Nerv zwischen sich fassen.“ More precise statements about the relations between tentacular arrangement, the canals and the anterior notches of radial calcareous segments are found in ÖSTERGREN's work [36, p. 4 with Fig. 1]. According to him, in *Pseudocucumis mixta*, the canals which join the two smaller tentacles in each radius, pass over slight notches on the two unequal processes of the radial segment. Though no mention is made as to the mode of branching of the four tentacular canals, it can be clearly seen from his figure that each radial canal gives off four tentacular canals in a regularly alternate manner on both sides, and that the smallest branch is given off last and goes over the narrower process of radial segments. Further, the same author has tried to show from LUDWIG's figure of the calcareous ring of *Orcula tenera* [26, Taf. VI., Fig. 17]\* that the five small tentacles, which we see in twenty-tentacled forms, are there totally absent, and that the narrower half of the radial segment is pointed at the anterior end, instead of being notched. The third tentacular canal which stands in connection with each of the five small tentacles, is given off from the radial canal dorsally in paired radii, and to the right in the midventral radius. If we carefully look into the numerous figures given by various authors of the calcareous ring of polychirotous Cucumarids, it will be found that the statements of ÖSTERGREN for *Pseudocucumis* and *Orcula* with regard to the relation between the

\* See also LUDWIG 25, p. 813, and Taf. XXX., Fig. 20.

anterior notches and tentacular canals are equally applicable for some other species; as f. i. *Pseudocucumis acicula* [LUDWIG 20, Taf. VI., Fig. 17], *Phyllophorus cebuensis* [THÉEL 46, Pl. IX., fig. 4; LUDWIG 26, Taf. VI., Fig. 10], *Ph. frauenfeldi* LUDWIG [20, Taf. VI., Fig. 22], *Ph. holothurioides* [LUDWIG 20, Fig. 23], and *Ph. celer* KOEHLER et VANEY [17, Pl. I., fig. 24]. Judging from SLUITER's figure of the calcareous ring of his *Orcula purpureo-punctata* [44, Taf. VI., Fig. 15], which clearly shows the presence of three notches in each radial segment, it seems highly probable that in that form there exist twenty tentacles, of which five were probably overlooked on account of their very small size. Also LUDWIG's statement [25, p. 814] that the anterior part of the calcareous ring of his *Phyllophorus bröcki* is exactly similar in form to that in *Orcula tenera*, leaves room for suspecting if he has not overlooked a small notch at top of the narrower process of radial segment.

Here it may be stated that in the Molpadiidæ the fifteen tentacles present are usually given off in the same manner as in *Orcula*. LUDWIG [28, p. 590] has stated in his work on *Ankyroderma musculus* (RISSO) that the branching of tentacular canals stands in intimate relation to the form of calcareous ring. Each radial canal should give off three tentacular canals in an alternate manner, and in paired radii the first and the third are always dorsally directed. The midventral radial canal should usually send out the first and the third tentacular canal to the right, but occasionally to the left. GEROULD [14, pp. 161—162] came to the same conclusion from his examination of *Caudina arenata* (GOULD). LUDWIG [26, pp. 87—88] and ÖSTERGREN [36, p. 4 and 37, p. 208] took the above branching mode as valid in all the forms of the family. CLARK [8, p. 137] has stated that "there are not three (tentacles) in each interradius, as might be supposed, but four in the middorsal interradius, three in each of the latero-dorsal interradii, three in one of the ventral interradii, and two in the other."



EDWARDS' statement concerning *Holothuria floridana* POURTALES [11, p. 251] seems to be suggestive of the fact that in twenty-tentacled Holothurids a supernumerary and the last acquired tentacle stands usually dorsal to the radial canal: thus, he says: "In the 7 cases with more than the normal 20 tentacles there appears a slight tendency to the addition of extra tentacles dorsally."

### 3. General consideration regarding the multiplication of tentacles.

On the basis of the data given above, it seems not unwarranted to conclude that the multiplication of tentacles takes place, at least in the group of the polychirotous Cucumarids, according to a general plan, as follows:—

All the tentacular canals spring from the radial canal separately and alternately on both sides. In paired radii the first or the proximalmost tentacular canal branches out from the radial canal on the dorsal side; the second stands opposite to the first, *i. e.* on the ventral side; the third is again on the same side as the first, and so on. In the midventral radius the canals usually branch out in a way congruent with those in radii of the right side, *i. e.* the first, the third, *etc.* are on the right, while the second, the fourth, *etc.* are on the left side. The more distal the branching point, the smaller is the diameter of the canal and the size of the tentacle it belongs to, and the nearer is the position of the tentacle to the median line of radius.

For the sake of convenience, the tentacles to which the first and second tentacular canals belong, may be called tentacles of the first order, and those in relation with the third and fourth canals, tentacles of the second order, and so on. Thus, when a certain Cucumarid is said to have tentacles of the first and second orders only, it denotes that there exist either fifteen or twenty tentacles in that form. The so-called "decachirotous" forms, such as *Cucumaria* and *Thyone*,

have tentacles of the first order only, the first and second tentacular canals on each radial canal branching out exactly opposite to each other.

Here I may add a remark with regard to *Pseudocucumis intercedens* LAMPERT, the only species with thirty tentacles among the Dendrochirotes. According to LUDWIG [23, p. 26], twenty of the tentacles are larger than the remaining ten, which form an inner circle and stand in pairs, the pairs recurring regularly at intervals of every four large tentacles. I am strongly inclined to think that the above enunciation is applicable to this case also. I assume that here each radial canal gives rise to six tentacular canals, *i. e.*, one in addition to the five tentacular canals to each radial canal of twenty-five-tentacled forms such as *Ps. japonicus* (textfig. 2). That additional tentacular canal is probably the distalmost or the sixth branch arising from radial canal next after, and on the opposite of, the fifth. Should this be the case, it might be expected that there exists, in each radial calcareous segment [23, Taf. I, Fig. 2], a small notch on each of the two processes forming between themselves the deep median indentation.

#### 4. Order of appearance of tentacles in ontogeny.

LUDWIG [30] appears to be the only author who has given any attention to the development of tentacles in polychirotous Cucumarids. For *Phyllophorus urna* GRUBE, he briefly stated that, so far as the first seven tentacles are concerned, the order of their appearance is similar to that he had observed in *Cucumaria planci* [27, pp. 183—184].\* In the latter species he discovered that „die beiden Fühler der beiden ventralen Interradien ihre Wasserkanäle vom mittleren ventralen Radialkanal erhalten, während der Fühler des mittleren dorsalen, sowie derjenige des linken dorsalen Interradius

\* See also diagrams given by BECHER 2, Taf. XXXVI, Fig. 43 or 3, p. 407, Fig. 1, a.

vom linken dorsalen Radialkanal und endlich der Fühler des rechten dorsalen Interradius vom rechten dorsalen Radialkanal versorgt werden.“\*...., „Der sechste und siebente“ continues the author, „liegen in Bezug auf die Medianebene der Holothurie einander genau gegenüber und erhalten ihre Wasserkanäle von denjenigen beiden Radialkanälen, welche sich bis dahin an der Abgabe von Fühlerkanälen überhaupt noch nicht beteiligt hatten, nämlich von dem linken ventralen und dem rechten ventralen.“...., „Beide Radialkanäle entsenden den neuen Fühlerkanal in dorsaler Richtung, also in den linken, bez. rechten dorsalen Interradius.“ The pairs of primary tentacles, given off from the left dorsal and the midventral radial canal, are each made up of exactly opposite and equal-sized tentacles; therefore it can not be determined whether these appeared simultaneously or not, and if the latter be the case, which appeared first. At any rate, from the fact that the right dorsal radial canal gives off the first tentacular canal *ventrally*, it may be inferred that the order of appearance of tentacular canals does not correspond with their manner of branching in the adult.

Of great interest is EDWARDS' observation [12, pp. 216—220] on *Holothuria floridana* that, in each radius, the tentacle which corresponds to the first in polychirotous forms invariably appears first, while that corresponding to the fourth appears last. Moreover, the order of appearance of the four tentacular canals from the midventral radial canal is exactly in agreement with the branching order seen in *Pseudocucumis africanus*.

#### 5. Systematic value of tentaculation in the Cucumariidæ.

The characters made use of for distinguishing genera and species

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\* Strangely enough a quite contradictory statement was made by the same author at another place, to the effect that the right dorsal radial canal gives off a tentacular canal „nur an seiner dorsalen Seite“ [27, p. 608].

of the Cucumariidae have hitherto been principally the number, size and arrangement of tentacles, the distribution of pedicels and papillæ, and the structure of calcareous deposits in the perisome as well as of the calcareous ring. The presence or absence of the posterior prolongations in radial calcareous segments seems to be scarcely of more than specific import, though their presence in association with the prolonged "main canals" seems to be very frequent in the sporadipodous forms, such as *Thyone* and *Phyllophorus*. I should think the construction plan of calcareous deposits in perisome may be of use for the distinction of genera or subgenera; however, we have as yet, as ÖSTERGREN has said [37, p. 212], no sufficient data in that regard to avail of. That the anterior notches in the radial calcareous segments are in close relation with the number, size and arrangement of tentacles, was first pointed out to be of importance in classification by ÖSTERGREN [36, p. 5].

As a result of my studies I have come to see that, at least within the subfamily Phyllophorinæ, the ordinal rank of the tentacles present—not a mere statement of their number—taken in conjunction with the anterior notches in the radial calcareous segments, is of greater importance than the distribution of pedicels and papillæ in distinguishing genera.

The distribution of pedicels and papillæ often varies very much according to individuals or to age in one and the same species. Both the genera *Semperia* LAMPERT and *Ocnus* FORBES present in that respect no distinct demarcation against the genus *Cucumaria*, and therefore must be included in the latter [LUDWIG, 26, p. 345]. HÉROUARD [16, p. 9] has shown that young *Cucumaria mendax* THÉEL has five rows of pedicels, as is said to be characteristic of *Ocnus*, but older individuals of that species resemble *Semperia* in that they possess additional pedicels scattered in a few number on interambulacra. A similar fact is also seen in *C. vegæ* THÉEL [46, p. 114]. According to LAMPERT [19, p. 61], *Orcula cucumiformis*

SEMPER has interambulacra either provided with pedicels in scattered distribution or totally devoid of these.

On the other hand, there are reasons to think that the number and arrangement of tentacles are something which is more constant than the distribution of pedicels and papillæ. The fact that, except in the Synaptidæ, the tentacles attain their full complement of number relatively early in the postembryonal development, is known from several cases of Holothurians, but unfortunately not from any polychirotous form.

All previous records of Cucumarid species said to possess tentacles in a number other than multiples of five, excepting the eight-tentacled *Sphærothuria bitentaculata* LUDWIG [29, pp. 148—149], are presumably based either on specimens which had accidentally lost some of their tentacles or on otherwise insufficient observations. It seems only fair to assume that except in abnormal individuals there can be no really congenital deviation of tentacle number from a multiple of five.

The two specimens of *Pseudocucumis japonicus* which were given by BELL [5, p. 253] to possess twenty-four tentacles, when later re-examined by BEDFORD [4, p. 845] were found to possess twenty-five and twenty-three tentacles respectively. MITSUKURI ascribed seventeen tentacles to a specimen of *Phyllophorus japonicus* [32], and fifteen to *Ph. fragilis* (see p. 82), but the specimens, as re-examined by me, were found to have in reality twenty tentacles each. While LAMPERT [18, p. 255] has described his *Pseudocucumis intercedens* to possess only eighteen tentacles, LUDWIG [23, p. 26] identified with it thirty-tentacled specimens.

Among the numerous specimens of *Pseudocucumis* examined by me, some were found to have a tentacle more and others with a few less than the normal number. The cases seem to deserve to be noticed here in short. One individual of *Pseudocucumis africanus* was provided with twenty-one tentacles, and another of *Ps. japonicus*

with twenty-six,—both therefore with an extra tentacle. They were laid out into sections and examined. In the former, the extra tentacle was found to belong to the category of the small ones and was situated in the left ventral radius. That tentacle communicated with a small canal which branched off dorsally from the fourth tentacular canal, and not directly from the radial canal. The latter specimen had the large extra tentacle in the right ventral interradius. Though I was unable, on account of unsuccessful sectioning, to clearly make out the origin of the tentacle in question, it seemed to belong to a canal branch given off ventrally either from the second tentacular canal or directly from the right ventral radial canal. In the two cases referred to, it is to be mentioned that the radial canal in relation to the extra tentacle did not branch in the regular normal manner, so that, f. i., the small extra tentacle of *Ps. africanus* does not correspond to the normal fifth tentacle (textfig. 2, D<sub>3</sub>) of *Ps. japonicus*. It is not to be wondered at if there should occur in the polychirotous group an abnormal form provided with supernumerary tentacles, the cause of which fact might be referred to the occurrence of six ambulacra as in the cases of *Cucumaria planci* [LUDWIG 22, p. 473] and *Ludwigia ocnoides* (DENDY) [REIFFEN, 40, pp. 615—716]. A case in which the tentacles were evidently naturally deficient in number (not as the result of mechanical loss) was presented by a small individual of *Pseudocucumis africanus*, measuring 15 mm. in length. It possessed only sixteen tentacles instead of twenty, the deficiency being due to absence of a radius, or more properly speaking, to the fact that the midventral radial canal was fused with the left ventral into a common canal up to the point where the second tentacular canal was given off. The existing radii, abnormally quadriradial in disposition, had each four tentacles as in normal cases.

A great objection against relying upon the number of tentacles in classification lies in the fact that the state of preservation of the

specimens often prevents accurate counting. Much more useful in the systematic seems to be the distribution of pedicels and papillæ, and above all, I should lay great emphasis upon the ordinal rank of the tentacular canals, which may be said to be fairly constant.

### 6. *The system of Phyllophorinæ.*

SEMPER's classification of Dendrochirota into three subfamilies, Stichopoda, Gastropoda and Sporadipoda, based on the distribution of pedicels [42, pp. 47, 61 and 64], as well as BELL's [5, p. 254] and LAMPERT's [18, p. 114] proposal to divide the group into Decachirota and Polychirota according to the number of tentacles, were both rejected by LUDWIG [26, p. 321 and 323] as being in no harmony with the natural relationship of the genera.

ÖSTERGREN in his recent paper [37, p. 212] has offered a new view on the system of Holothurioidea, establishing under the family Cucumariidæ the three subfamilies, Cucumariinæ, Phyllophorinæ and Psolinæ. These three subfamilies are practically synonymous with Decachirota, Polychirota and Gastropoda respectively. Nevertheless, ÖSTERGREN's above view seems to me to be acceptable, since, firstly, it is desirable to derive family or subfamily name from the type genus; secondly, since the polychirote-gastropodous form *Théelia* LUDWIG can not find its proper position in any of the old subfamilies, and thirdly, since the Cucumariinæ and Phyllophorinæ differ from each other not only in tentacle number but also in other anatomical features.

Tabulating the various forms of the Phyllophorinæ with respect to the arrangement of ambulacral appendages, we have the following:—

Distribution of pedicels and papillae. Arrangement of tentacles & their number.		Pedicels arranged in distinct rows in ambulacra.		Pedicels distributed in both ambulacra and interambulacra; scarcely or not at all showing zonal arrangement.
		Interambulacra devoid of pedicels.	Interambulacra with a few papillae or pedicels.	
In 2 orders.	15	<i>Orcula discrepans</i> .	<i>Orcula cucumiformis</i> .	<i>Orcula</i> (most species).
	20	<i>Pseudocucumis</i> (most species).	<i>Actinocucumis</i> .	<i>Phyllophorus</i> .
In 3 orders.	25	<i>Pseudocucumis japonicus</i> .		
	30	<i>Pseudocucumis intercedens</i> .		

It is obvious that the system of the Phyllophorinae as it now stands is in much confusion. The genus *Orcula* includes all the fifteen-tentacled forms and even the stichopodous species *O. discrepans* SLUITER, while *Pseudocucumis* includes forms in which the tentacles number 18—30, and in which the zonal arrangement of pedicels is much pronounced.

I agree with ÖSTERGREN [33, p. 103; 34, p. 9; 35, p. 659 and 36, p. 23] in uniting *Orcula* with *Phyllophorus*. As reasons thereof I may adduce, firstly, the fact that the presence of a fourth tentacle in each radius of any twenty-tentacled form is often difficult to make out and is thus liable to be overlooked; and secondly the fact that tentacles number fifteen or twenty can not be made a definite criterion for separating the two genera, since the third and fourth tentacles may easily be taken for a pair belonging to the second order. The same may be said for the genus *Pseudocucumis* which should include the stichopodous forms with 15—20 tentacles. I see no reason for assuming generic difference between *Orcula discrepans* [SLUITER 44, p. 110] and *Pseudocucumis quinquangularis* SLUITER [44, p. 108], the former said to have fifteen tentacles and the latter eighteen. Further, the species *O. cucumiformis* should also be referred to



*Pseudocucumis*, as we find an analogous case in the genus *Cucumaria*, which includes forms with scattered pedicels in interambulacra, formerly distinguished by LAMPERT as *Semperia*.

*Pseudocucumis japonicus* with twenty-five tentacles and *Ps. intercedens* with thirty tentacles had better be transferred to the genus *Amphicyclus* BELL.

## II. Descriptions of Species.

Subfamily **Phyllophorinæ** ÖSTERGREN, 1907.

Body cylindrical or spindle-shaped, with terminal mouth and anus; ventral surface not forming any sort of creeping sole. Tentacles 15—30 in number, in two or three orders. Third limb of alimentary tract running along left side of midventral radial muscle.

Six species of the group are known to occur in Japan. Amongst them one seems to be new, and another is a doubtful species. They may be distinguished as follows:—

- a.* Tentacles of the third order present, numbering 25 in all; pedicels limited to ambulacral zones; calcareous deposits usually absent from general body surface, but there occur tables with two-pillared spire in the introvert\* ..... *Amphicyclus japonicus*.
- aa.* Tentacles in two orders only, numbering 15—20 in all.
  - b.* Pedicels confined to ambulacra; calcareous deposits of general body surface in the form of large lenticular perforated plates....  
..... *Pseudocucumis africanus*.
  - bb.* Pedicels distributed on both ambulacra and interambulacra.
  - c.* Tentacles 15; calcareous deposits absent from body-wall.....  
..... *Phyllophorus limaenotus*.
  - cc.* Tentacles 20; calcareous deposits present in body-wall.
  - d.* In the introvert only tables with two-pillared spire; in general perisome tables in which spire is usually much reduced or has

\* I follow EDWARDS [10, p. 54] to call by this name the anterior part of body which can be introverted.

- disappeared.....*Ph. japonicus*.  
*dd.* In the introvert rosettes only ; in general perisome tables with  
 spire consisting of four or more pillars.  
*e.* Tables very thinly scattered on body surface, so that the  
 skin is soft to the touch ; spire of tables rudimentary .....  
 ..... *Ph. fragilis*.  
*ee.* Tables profusely present on body surface, rendering the skin  
 rough to the touch ; spire of table very tall....*Ph. hypsipyrus*.

Genus *Amphicyclus* BELL.

*Amphicyclus* BELL, 1884 [5], p. 254.

Type.—*A. japonicus* BELL.

The generic diagnosis given by BELL is as follows :—

“Stichopod arrangement of the suckers associated with the possession of more than ten oral tentacles ; the tentacles in two circles ; those of the inner are arranged in pairs, are ten in number, radial in position, smaller than those of the outer circle, in which there are fourteen subequal tentacles. There are no calcareous pharyngeal plates, and two of the retractors of the pharynx are united with one another.”

Now, if my identification of the specimens on hand with *A. japonicus* be right, I should propose to define the genus as following :—

Tentacles of unequal size 25—30 in number, present in three orders. Small tentacles in five pairs, which are radial in position and regularly alternate with pair of larger ones, form the inner circle. Pedicels limited to ambulacra, interambulacra being naked. Radial segments of calcareous ring without posterior prolongations. Calcareous deposits of general perisome in the form of tables with spire consisting of two pillars.

Except in tentacle number, this genus closely approaches *Pseudocumis*. Two species belong to the genus, namely *A. japonicus*

BELL and *A. intercedens* (LAMPERT).

1. *Amphicyclus japonicus* BELL.

(Pl. I., figs. 5-6; textfigs. 2-3).

*Amphicyclus japonicus* BELL, 1884 [5], pp. 253-254.—LAMPERT, 1885 [18], p. 181.—THÉEL, 1886 [46], p. 126.

*Pseudocucumis japonicus* LUDWIG, 1887 [24], p. 1239.—AUGUSTIN, 1908 [1], p. 29.

*Pseudocucumis japonica* LUDWIG, 1889-'92 [26], p. 348.—BEDFORD, 1899 [4], pp. 844-845.

Habitat.—Tsugaru Strait. Lat.  $41^{\circ} 12' N.$ , long.  $140^{\circ} 45' E.$ , 43 fms., sand and mud: 2 specimens (BELL).

Uraga Channel. Lat.  $35^{\circ} 13' N.$ , long.  $139^{\circ} 44' E.$  (AUGUSTIN).

Numa, Sagami Sea (Matsuwa-lighthouse-line, Mera out or not quite out), 260 fms.: a single specimen (K. MITSUKURI & K. AOKI coll., Aug. 22, 1903. Sci. Coll., Spec. No. 1739).

Northern part of Suruga Bay, 275 fms.: a single specimen (K. AOKI coll., June 1, 1905. Sci. Coll., Spec. No. 1743).

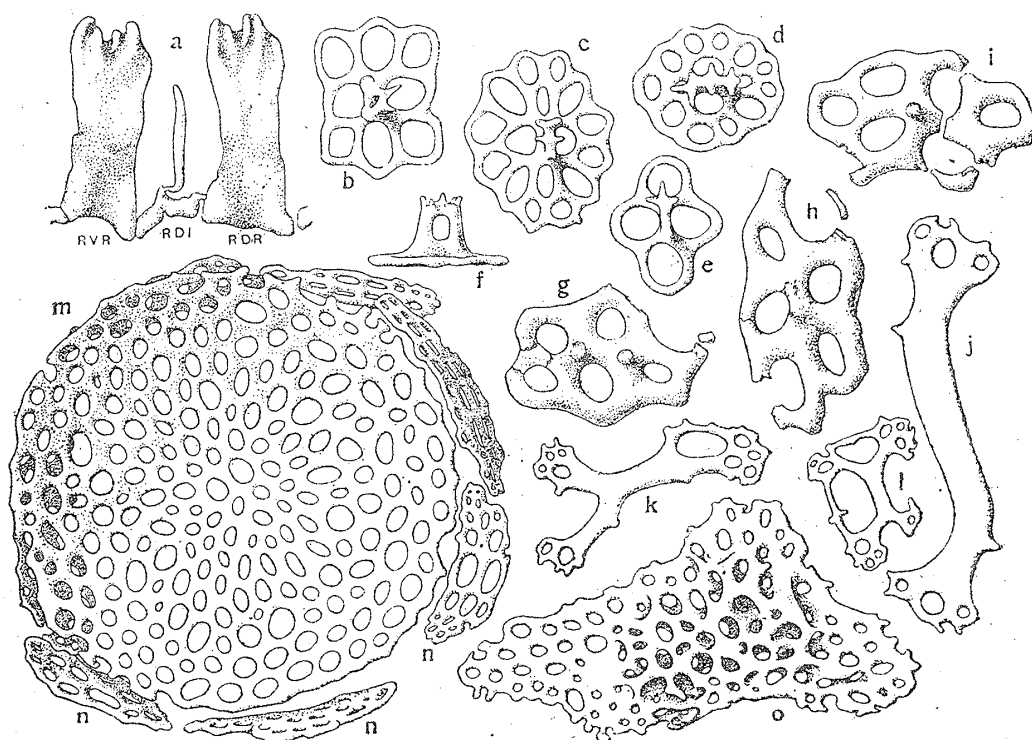
Tōkyō market, probably from the Province of Echizen: 4 specimens (S. TANAKA don., Feb. 15, 1911. Sci. Coll., Spec. No. 1738).

Size and form.—The single specimen from Sagami Sea (Pl. I., fig. 5) is in fully extended state. Body slender, gradually tapering at both ends. Length 51 mm. exclusive of tentacles; diameter of the thickest part 7 mm. The Suruga Bay specimen is also well extended: length 45 mm.; maximum diameter 11 mm. The remaining four specimens are much contracted, though some of them have the introvert protruded (Pl. I., fig. 6): body cylindrical, bluntly ending at both extremities, the largest measuring 48 mm. long and 11 mm. thick.

Color.—General perisome light brown to deep greyish brown; very lightly colored in distended parts. Pedicels of a light brown, whitish at tip. Introvert and tentacles pure white.

Integument.—Finely wrinkled all over, except on introvert which is quite smooth; thick and muscular in contracted specimens, but very thin and leathery in extended ones.

Tentacles.—Twenty-five in number, present in three different sizes (textfig. 2). As measured in a small but fully extended specimen, the largest ten tentacles situated pairwise in each inter-radius attain a length of 5 mm. The five medium-sized tentacles, radial in position, are 3 mm. long. The smallest ten tentacles, occurring in a pair in each radius, are only 1 mm. long; they form an inner circle to that of the others.



Textfig. 3.

*Amphicyclus japonicus* BELL. a Three consecutive segments of calcareous ring viewed from axial side. b-e Tables from introvert seen from above; f same seen from side. g-i Imperfect tables from general perisome. j Supporting rod of tentacle. k-l branched rods from tip of tentacle. m End-plate of pedicel; n curved perforated plates surrounding the end-plate. o anal tooth. (a  $\times 6$ , b-l  $\times 300$ , m-o  $\times 150$ ).

Pedicels.—Pedicels seem to be but little retractile and measure 2.5—3 mm. in length. They form a zigzag row in each ambulacrum, though in contracted specimens they are often seen in a double or quadruple row. Near ends of body they are arranged in a single row in each ambulacrum. Interambulacra are naked.

Calcareous deposits.—Tables are always found in the introvert (textfig. 3, b—f). The disk is usually oval with entire or sometimes wavy margin (c—d); its longer diameter 0.045—0.07 mm., and the shorter 0.03—0.06 mm. Holes 4—16 in number, usually regularly distributed; of the four larger holes, which are separated from one another by the primary cross, one pair is larger than the other. Spire 0.025—0.03 mm. high, consisting of two pillars united at top to form a crown armed with 4—8 teeth (f). Only in the specimen from Sagami Sea, which appears to be the youngest of all I have had, some calcareous deposits are found very sparsely in the general perisome. These are imperfect in form, being fragmentary or partly dissolved; the more perfect forms I have found are shown in text-figure 3, g—i. The deposits may be said to be of the form of a table with two rudimentary pillars and with four central and some peripheral holes. The largest measured was 0.105 mm. long and 0.055 mm. broad. Around the anus there exist five anal teeth (o), each irregularly triangular in form and lying with the obtuse tip directed posteriorly. They attain 0.35 mm. in length and 0.22 mm. in breadth. Besides them, there are found in their proximity some scattered X-shaped rods similar to those of tentacles, together with imperfectly shaped end-plates. In pedicels a single end-plate and a small number of supporting buttons are found. The end-plate (m) is well developed, its diameter varying within range of 0.25—0.4 mm. The supporting buttons or curved plates (n) are found only in the vicinity of the end-plate. They are up to 0.14 mm. long and about 0.05 mm. broad, and are curved in adaptation to the curvature of the wall of pedicel; they are pierced by holes in two or

three rows. The tentacles are supported by rods and X-shaped bodies of various sizes. The rods (j) are usually recurved, 0.08—0.2 mm. long, and are supplied at both ends with a few holes. At tip of the branches of tentacles there are various forms of X-shaped bodies (k—l), which can be derived from the above mentioned rods. Their length measures 0.06—0.1 mm.

Calcareous ring.—Weakly calcified and imbedded in the connective tissue, so that in young individuals it is liable to be overlooked. In large individuals, however, they can be readily found and examined. Radial segment (a, RVR and RDR) 4.5 mm. long, 1.6 mm. broad, and without posterior prolongations; on its anterior margin are found four notches, one for radial canal and the remaining three for tentacular canals. Interradial segment (a, RDI) slender, of the form of inverted Y, measuring 3 mm. in length and 1.5 mm. in breadth.

Musculature.—The retractors are inserted to radial muscles at different points of body length: the retractor of midventral radius is inserted most anteriorly, while those belonging to dorsal radii are inserted most posteriorly. As measured in a specimen 51 mm. long, the retractor of the midventral radius has its insertion at a point 24 mm. distant from the posterior body end, *i. e.*, at about the middle of the body; retractors of ventral lateral radii at a point 21 mm. *i. e.*, about two-fifths the body-length, from same; and those of dorsal radii at 18 mm. *i. e.*, about one-third the length, from same. In contracted specimens both circular and radial muscles are quite thick.

Polian vesicle.—Usually single, situated in the left dorsal interradius. Its length varies from 5 to 11 mm. Very often there is found an accessory vesicle of 7—11 mm. length in the left ventral interradius.

Stone-canal.—Situated on the right side of dorsal mesentery, ending with a kidney-shaped madreporite similar to that found in *Cucumaria calcigera* (STIMPSON) and first described by EDWARDS [10, p. 57]. In length it reaches 2—2.5 mm., including the

madreporite which is 1—1.5 mm. in diameter.

Digestive tube.—Variable in calibre as well as in length. About 15 mm. behind the calcareous ring, the tube enlarges itself to form a stomach of about 2 mm. diameter. The third limb of the intestine is suspended by a mesentery attached to the left of midventral radial muscle. The entire digestive tube is 72 mm. long in a specimen of 51 mm. length; while in a contracted individual 48 mm. long, it measured as much as 190 mm. in length.

Respiratory trees.—Two in number, each running along dorsal lateral interradius; their length may reach to three-fourths that of extended body.

Genital tubes.—In two tufts, the tubes branching once or twice near base. Genital papilla could not be made out.

Remarks.—As regards the size and color of this species BELL has given no statement. The identification of the above described specimens with the species of BELL seems to be justified by the following facts: 1) the presence of twenty-five tentacles is a feature unique in the Cucumariidæ; 2) the localities of both BELL's and AUGUSTIN's specimens either agree with those of mine or stand with these under the influence of the same current; 3) "the complete absence of rods or spicules from the walls of body or tube-feet" in my specimens excepting the youngest individual observed by me; 4) the presence of "terminal plates of the tube-feet, and the delicate and elegant bars which are found in the tentacles"; and 5) the weak development of calcareous ring, of which BELL found no sign but was supposed by LUDWIG [26, p. 83] to be present in an imperfect condition.

As to the two retractors approaching and uniting with each other as given by BELL, I should say with LUDWIG [24, p. 1239] that such an occurrence may be met with in individual cases but does not seem to constitute a constant character of diagnostic value. Besides from v. MARENZELLER's observation [31, p. 135], I can give

a number of such abnormal retractors from my own observations in some other polychirotous forms. The attenuation of the hinder end and the thick integument of the anterior body end in BELL's specimens are, I suppose, merely due to the state in which the specimens were killed. Genital tubes filling the greater part of body-cavity in a large number can scarcely be taken for a matter of specific importance as BELL has considered it to be. In my specimens the number of tubes and their thickness vary very much according to sex as well as to the season of capture.

After all I have said, the diagnosis of the present species may be emended as follows:—

Body cylindrical, truncate or tapering at both ends. Body length may exceed 50 mm. General perisome greyish brown, tip of pedicels light brown, tentacles and introvert white. Tentacles twenty-five in number, in three different sizes; the largest ten standing in five pairs which alternate with the medium-sized five, these being radially situated. The small ten tentacles arranged pairwise on each radius, forming inner circle of tentacles. Pedicels limited to ambulacra, arranged in a zigzag row or in 2—4 rows. Integument soft, usually without any calcareous deposit. Tables with spire made up of two pillars are found in the introvert. End-plate of pedicels as well as anal teeth present. Tentacles supported by recurved or branching rods. Calcareous ring weakly calcified; radial segment with four unequal anterior notches, but without posterior prolongations; interradial segments slender, of the form of inverted Y. Polian vesicle usually single, hanging in the left dorsal interradius, but often with an accessory vesicle in the left ventral interradius. Stone-canal provided with reniform madreporite. Genital tubes once or twice branched, in two tufts.

Genus *Pseudocucumis* LUDWIG.

*Pseudocucumis* LUDWIG, 1874 [20], p. 14.—1886 [23], p. 27. —1887 [24], p. 1241.



Type.—*P. acicula* (SEMPER).

LUDWIG at first limited the tentacle number of the genus to twenty; later he made the genus to comprehend forms with from eighteen to thirty tentacles, and finally those which have more than fifteen tentacles of unequal size.

On the basis of my view on the system of Phyllophorinæ, I propose to change the generic diagnosis with regard to the number of tentacles and the distribution of pedicels. Since in my opinion *Orcula discrepans* and *O. cucumiformis* should be referred to *Pseudocucumis*, while *P. japonicus* as well as *P. intercedens* should be removed from it, the genus may be defined as follows:—

Tentacles in two orders: 15—20 in number, unequal in size. The smaller tentacles stand as a rule alternately with the larger ones, all or a part of the former forming an inner circle of tentacles. Pedicels limited to ambulacra, but sometimes scattered in a few number on interambulacra also.

## 2. *Pseudocucumis africanus* (SEMPER).

(Pl. I., fig. 4; textfigs. 1 and 4).

*Cucumaria africana* SEMPER, 1868 [42], p. 53.

*Cucumaria assimilis* BELL, 1886 [6], p. 27.

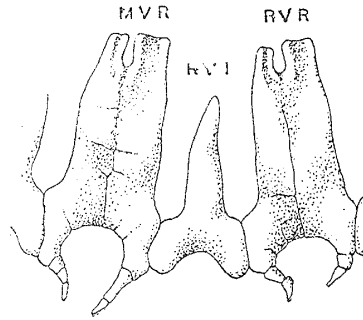
*Pseudocucumis theeli* LUDWIG, 1887 [24], p. 1236.

*Pseudocucumis africana* LUDWIG, 1888 [25], p. 815.—MITSUKURI, MS. [32].

Besides the numerous specimens from Kyūshū and Riū-Kiū Islands, which were studied by the late Professor MITSUKURI, I have two specimens from Takanoshima in the Bay of Tateyama in Province Awa, lat. 34° 59' N., long. 139° 51' E. (Sci. Coll., Spec. No. 1737). This is the northernmost locality known for the species. They were collected by Mr. K. KAWAGUCHI on July 30, 1910.

The two specimens measure in length respectively 32 mm. and 25 mm., both with the introvert in well extended state (Pl. I., fig. 4).

The color is a deep brownish purple all over, somewhat lighter on ventrum than on dorsum. All the viscera are of a uniform purple color, probably due to staining after preservation. As to calcareous deposits of the perisome, it may be worth while to note that in the introvert I have found only the rods described and figured by LUDWIG [24, p. 1238 and Taf. XV., Fig. 15], the lenticular plates characteristic of the species being there totally absent. As to other characters of the species, except as regards the asymmetry of the calcareous ring (textfig. 4) and the arrangement of tentacles (textfig. 1) before enunciated, I have nothing to add to the descriptions given by previous observers.



Textfig. 4.

Three consecutive segments of the calcareous ring of *Pseudocucumis africanus*, viewed from the axial side. ( $\times 10$ ).

Genus *Phyllophorus* GRUBE (LUDWIG emend.)

(+ *Orcula* TROSCHEL).

LUDWIG [24, p. 1240—1241] last defined the genus to have unequal sized tentacles more than fifteen in number, of which the smaller stand alternately with the larger, all or a part of the former forming an inner circle of tentacles. ÖSTERGREN's suggestion to unite *Orcula* with the present genus seems to be reasonable, as I already mentioned at the end of Part I of this paper. Moreover, the genus should comprise a Hawaiian species recently described by FISHER [13, pp. 713—715] under the name of *Thyonidium alexandri*, in which ventral interambulacra are naked. Consequently, in my opinion, the genus should be defined as follows:—

Tentacles in two orders: 15—20 in number, unequal in size. The smaller tentacles stand as a rule alternately with the larger ones, sometimes (in forms with 20 tentacles) forming an inner circle. Pedicels scattered all over body, seldom showing zonal arrangement on ambulacra; some interambulacra may be naked.

### 3. *Phyllophorus limaconotus* (BRANDT).

*Cladolabes limaconotos* BRANDT, 1835 [7]; pp. 57—58.

*Holothuria limaconotus* SELENKA, 1867 [41], p. 331.

*Orcula limaconotus* LUDWIG, 1881 [21], p. 589.—LAMPERT, 1885 [18], p. 169.—THÉEL, 1886 [46], p. 149.—LUDWIG, 1889—'92 [26], p. 347.

Only a single specimen of this species is known from the Bonin or Ogasawara Islands, and that very imperfectly. While in the original description of BRANDT the tentacles were stated to be twenty in number, LUDWIG [21] later found them in the same specimen to be only fifteen. From the bad state of preservation of the specimen, it can not be decided if the absence of any calcareous deposit from the perisome as well as from the pedicels can be taken as a real character of the species. It seems highly probable that this is not a good species, and had perhaps better be united with *Phyllophorus tener* (= *Orcula tenera* LUDWIG) or some other species of *Phyllophorus*.

### 4. *Phyllophorus japonicus* (v. MARENZELLER).

(Pl. I., fig. 2; textfig. 5).

*Thyonidium japonicum* v. MARENZELLER, 1881 [31], p. 134, Taf. V., Fig. 9.

*Phyllophorus japonicus* LUDWIG, 1889—'92 [26], p. 347, Taf. VI., Fig. 16.—MITSUKURI, MS. [32].

Habitat.—Japan: 2 specimens (v. MARENZELLER).

Haneda, Tōkyō Bay: a single specimen (MITSUKURI).

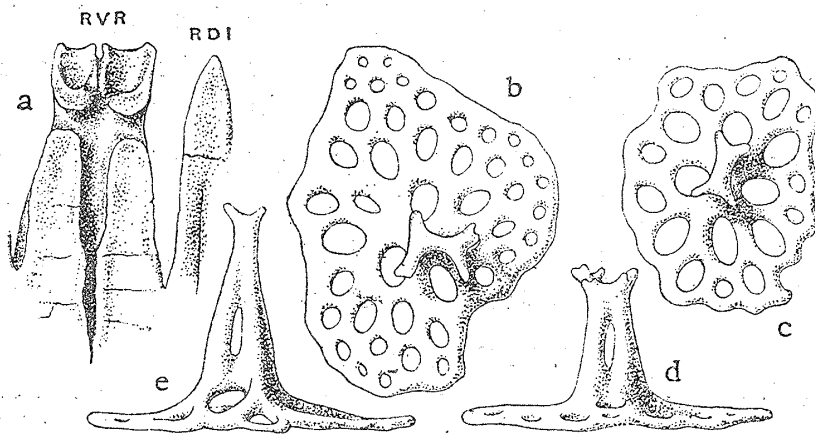
Off Tsurugizaki, Uraga Channel: a single specimen (MITSUKURI).

Sagami Bay (Takeyama over Kurozaki), 40 fms.: a single specimen (MITSUKURI).

Southern part of Ōsaka Bay, about 8 fms.: a single specimen (K. AOKI coll., Mar. 8, 1903. Sci. Coll., Spec. No. 1746).

I have examined the last named specimen, and I may here put down some points which differ from, or are not mentioned in, the descriptions given by v. MARENZELLER and MITSUKURI.

The specimen (Pl. I, fig. 5) is strongly contracted, being of a thick spindle-like shape. Length 71 mm., breadth 39 mm., and height 32 mm. The skin is thick and stiff, rough to the touch, and full of creases. Wart-like contracted pedicels white, creases of a reddish brown color. Of the twenty greyish black tentacles, ten are large and the rest small. In the introvert tables (textfig. 5, b—d) only are found. The disk is of an irregular shape, ranging in diameter 0.09—0.13 mm. but most commonly 0.10—0.12 mm. Holes number 12—15, sometimes even more than 40; spire consisting of



Textfig. 5.

*Phyllophorus japonicus* (v. MARENZELLER). *a* Anterior parts of the right ventral radial segment of the calcareous ring, with an adjoining interrarial segment, seen from axial side. *b—c* Tables from introvert, seen from above; *d* same seen from side. *e* Table from tentacle, seen from side. (*a*  $\times 3$ , *b—e*  $\times 300$ ).

two pillars which unite with each other but once, forming four teeth at apex. Height of spire is usually about 0.05 mm., but may reach 0.08 mm. near and in the tentacles (c). In the general perisome the tables are incomplete, changing into irregular perforated plates of various shape as figured by v. MARENZELLER [Fig. 9, a]. Tentacles supported by somewhat irregular tables and perforated rods as well as by a few rosettes. Peculiarly modified tables of the form of a tripod, described by v. MARENZELLER and MITSUKURI as supporting pedicels, I could find only in the pedicels located in the anteriormost parts. End-plate of pedicels imperfect and small, consisting of irregularly branched rods; its diameter varying within a range of 0.14—0.15 mm.

Calcareous ring (a) is 40 mm. long, and is composed of numerous small pieces as is well known. Retractors inserted on body-wall at different points of radial muscles: those of dorsal radii inserted in the middle of the length of the contracted body, those of ventral lateral radii at a distance from the posterior end equal to about eight-thirteenths the length of the respective radial muscle, and the mid-ventral retractor at a distance from the posterior end of more than two-thirds the length of the arched midventral radial muscle.

A tubular Polian vesicle, 38 mm. long and 30 mm. in diameter, hangs on the circular canal in the left dorsal interradius. Stone-canal 7 mm. long, with an ellipsoidal madreporite about 1 mm. long. The third limb of intestine runs along the left side of the midventral radial muscle. The respiratory tree in each dorsal lateral interradius extends nearly throughout the entire body-length.

5. *Phyllophorus fragilis* MITSUKURI & OHSHIMA, sp. n.

(Pl. I., fig. 3; textfig. 6).

In his manuscript the late Professor K. MITSUKURI provisionally considered this species to be new and described it as follows:—

“Specimens examined.—12 specimens from Sakibaru near Naha,

Okinawa Island; collected by me on dead coral reef, Apr. 7, 1901 (No. 1657). 9 specimens from Nishino-omote, Tanegashima, Satsuma; S. IKEDA coll., Jan. 4, 1905 (No. 1658). 1 specimen from Satsukawa, Amami-Ōshima; MITSUKURI and YASUDA coll., Mar. 31, 1901 (No. 1659).

"Size.— $6.5 \times 1.9$  cm. (a large one in lot no. 1657);  $2.8 \times 1.4$  cm.,  $3.1 \times 1.7$  cm.,  $2.25 \times 1.3$  cm. (small ones in lot no. 1657).

"Shape.—Spindle-shaped, tapering towards both ends.

"Color.—Uniformly brown in alcohol. In one specimen some large patches on the body. In life I have observed a purple tinge on the animal, but can not remember exactly how this was caused.

"Pedicels.—Scattered irregularly all over the body in ambulacra as well as in interambulacra. In most specimens they are more crowded on ventral than on dorsal surface. In some, longitudinal arrangement of pedicels is recognizable, especially towards the posterior end. The ventral ambulacra seem to possess three or four rows of pedicels each, leaving narrow interambulacral spaces free of pedicels.

"Tentacles.—Fifteen in number; in one specimen ten large and five small, in another eleven large and four small.

"Calcareous ring.—Both radialia and interradialia made up of numerous small pieces. Radialia anteriorly with three notches, posteriorly with two prolongations made up of eight or more small pieces joined together. Interradialia pointed anteriorly, each wedging itself between the posterior prolongations of two adjoining radialia, consisting of several small pieces. Hind ends of posterior radial prolongations continuous with corresponding ends of adjoining radialia.

"Retractor muscles thick, short, attached to body-wall at about  $\frac{1}{4}$  the body length from the anterior end of body.

"Polian vesicle one. Stone-canal probably one.

"Calcareous deposits.—None in any part (the neck portion not excepted) of the body-wall of most specimens. In some (at least in one young specimen of  $2.25 \times 1.3$  cm.) there are found tables in

sparsely scattered distribution. These have complete or incomplete disk. Complete disks show four central holes and eight large peripheral holes, their margin being tolerably smooth and slightly wavy. Incomplete disks are of all sorts. There may exist central holes only, or one or more of the peripheral holes may not be closed in. In none there is a complete spire, this being represented generally by four short knobs which do not unite at all. In one case, I thought to have seen one cross-piece, but I am not sure of it, as I could obtain the view from above only. In tentacles there are small rosettes. In pedicels of some specimens there exist incomplete rosettes in a greater or smaller number.

"This species is very common on dead coral reefs near Naha, Okinawa Island. It lives buried in coral sand. One great characteristic of it is that it throws out viscera with the least touch, making it very difficult to obtain specimens with the viscera intact. Mr. IKEDA observed the same fact and remarked: 'As soon as the stone under which these animals live are lifted up, they throw off the viscera, even before they are touched in any way.'

"I am much surprised that I can not identify these specimens with any of the known species. I can not think that SEMPER and others who have explored tropical or subtropical seas, did not obtain these animals, for I suppose the species extends further south than the Okinawa group. Not improbably it occurred among the collections previously studied, but has remained mixed up with some others in the present chaotic state of the species of the genera *Orcula*, *Phyllophorus*, *Thyonidium*, &c.

"I name this provisionally *Phyllophorus fragilis*. If the genus *Orcula* is to be retained, I suppose the species should be placed in that genus; but it seems to me that *Orcula* is only a special case of *Phyllophorus* and I am inclined to agree with ÖSTERGREN in merging it into *Phyllophorus* (ÖSTERGREN 1898, p. 103, footnote)."

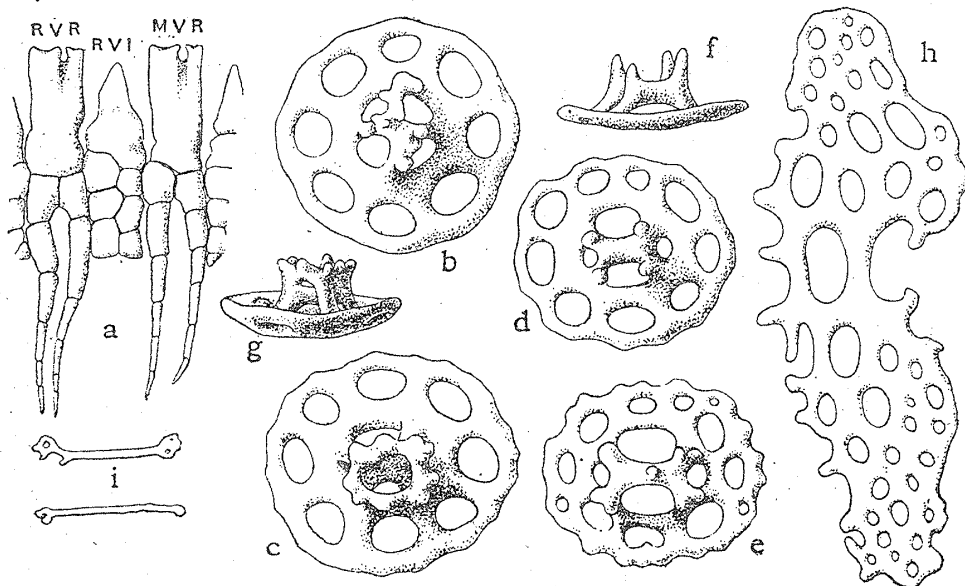
The results of my own observations on the specimens examined

by the late Professor MITSUKURI as well as on four more specimens collected by Dr. M. MIYAJIMA at Naha on May 25, 1900 (Sci. Coll., Spec. No. 1747), differ in some respects—above all in regard to the tentacle number and the calcareous deposits—from the above cited statements. They may be given as follows:—

Form and size.—All specimens are much contracted, eviscerated and have introvert drawn in. The least contracted of them is shown in Pl. I., fig. 3. This is of a somewhat cylindrical shape, but is strongly curved. Its length is 57 mm. along the middorsal line and 91 mm. along the midventral; greatest diameter 16 mm. In all other strongly contracted specimens the body is spindle-shaped.

Integument.—Muscular, quite soft to the touch.

Tentacles.—Invariably twenty in number. The largest ten tentacles 12—18 mm. long in the contracted state; the medium-sized five tentacles 5—8 mm. long; the smallest five tentacles radial



Textfig. 6.

*Phyllophorus fragilis* MITSUKURI & OHSHIMA, sp. n. a Three consecutive segments of the calcareous ring seen from abaxial side. b—e Various forms of tables from general perisome and pedicel, viewed from above; f—g same seen from side. h Perforated plate situated near the end-plate. i Supporting rods of tentacle. (a  $\times 3$ , b—i  $\times 300$ ).



in position, only 2 mm. long and liable to be overlooked in the contracted state.

Calcareous deposits.—Except in introvert, tables are quite sparsely scattered in all parts including the wall of pedicels. Their disk (textfig. 6, b—e) is usually of a roundish outline with smooth or rarely serrated margin, the diameter varying within a range of 0.05—0.09 mm. They are more or less regularly perforated by a large central hole and eight or more peripheral holes. Over the central hole there is spanned a cross-shaped arch, from which arise four rudimentary pillars of 0.02 mm. height (f). The pillars but seldom branch on top and there form an incomplete toothed crown (c and g). Rosettes are profusely found in introvert and anal region, but in a very small number in tentacles and pedicels. They are oval in general outline, measuring 0.02—0.06 mm. in the longer diameter. End-plates are well developed, their diameter varying from 0.15 mm. to 0.4 mm. in accordance with the size of pedicels. Around the end-plate there are found a number of elongate perforated plates or supporting buttons without knob (h). At tip of tentacles there are found delicate supporting rods (i) in very thinly scattered distribution. They measure 0.04—0.09 mm. in length and are provided with one or two holes at both ends. Rudimentary anal teeth consisting of a loose calcareous network are present. Anal papillæ are supported by irregular perforated plates.

Calcareous ring.—Radial segment (a, RVR and MVR) 13—17 mm. long and 2 mm. broad, with the anterior margin divided into two unequal halves by a deep notch (a). Posterior prolongations composed of about six pieces. Interradial segments (RVI) 8—12 mm. long and 1.5—2 mm. broad, each composed of several pieces.

Retractor muscles.—Inserted at different levels, the midventral one most anteriorly. In the specimen represented in fig. 3, Pl. I., those of the dorsal pair are inserted to respective radial muscle at a distance of five-elevenths, those of the ventral pair at that of two-

sevenths, and the unpaired midventral at that of two-ninths the length of same from the anterior end. In another specimen the same distances were respectively two-fifths, a quarter and one-fifth the length of the radial muscle in relation.

Polian vesicle.—Usually single, situated in the left dorsal interradius, 5—10 mm. long. In one specimen two vesicles were found hanging together in the same interradius.

Stone-canal.—Situated on dorsal mesentery, 1.5—3 mm. long, provided with a minute madreporite.

Respiratory trees.—Two, each running along the whole length of dorsal lateral interradii.

Genital tubes.—In bundle on both sides of dorsal mesentery, about 7 mm. long, once or twice dichotomously dividing.

From the foregoing remarks, the present species may be diagnosed as follows:—

Body usually spindle shaped in contracted state; length up to 65 mm. Color of general perisome uniformly brown, or with purple patches. Tentacles twenty in number, of three different sizes: ten large, five medium-sized, and five small. Pedicels scattered all over body surface, somewhat more numerous on ventral than on dorsal surface; zonal arrangement sometimes recognizable. Integument soft, with very sparsely scattered tables showing a large central hole and eight or more smaller peripheral holes in the disk, and four low pillars which may sometimes unite with one another at top. Well developed end-plate and rudimentary anal teeth present. Introvert provided with rosettes only, similar deposits being also found in anal region and in a small number in pedicels and tentacles also. Tip of tentacles provided with delicate rods. Both radial and interradiial segments of calcareous ring consist of several small pieces. Radial segment with long posterior prolongations and three anterior notches. Polian vesicle single, situated in left dorsal interradius. Stone-canal small. Genital tubes in two tufts, once or twice branched.

Remarks.—This species comes very close to *Phyllophorus cebuensis* with regard to their color, habitat and calcareous tables. But in that species, as unanimously given by authors, interradian segments of the calcareous ring are simple, while no other calcareous deposit than tables has been given to exist [SEMPER 42, p. 67, Taf. XII., Fig. 5; Taf. XIII., Fig. 25; Taf. XV., Fig. 8; PEARSON 38, pp. 194—195, Pl. II., figs. 22—24; 39, p. 191]. The specimen described by THÉEL under the name of *Thyonidium cebuense* [46, p. 95, Pl. IX., fig. 4], which PEARSON [38] proposed to distinguish as var. *theeli*, is doubtlessly different from ours, in that it possesses much modified tables in pedicels. Our species also appears to be allied to *Phyllophorus tener* in having a sparse number of tables of similar size and form and in having calcareous ring of a similar structure. The two forms are, however, markedly different in the number of tentacles and in the presence of “Kalkconcretionen” [LUDWIG 20, p. 19, Taf. VI., Fig. 21, b] instead of rosettes. As regards *Ph. tener*, the fact reported by SLUITER [43, p. 208] that that species lives quite a long time in aquarium, seems to indicate a point of its difference from *Ph. fragilis*, which, according to MITSUKURI's observation, is a very difficult animal to handle without causing evisceration.

6. *Phyllophorus hypsipyrus* (v. MARENZELLER).

(Pl. I., fig. 1; textfig. 7).

*Orcula hypsipyrus* v. MARENZELLER, 1881 [31], pp. 135—136, Taf. V., Fig. 10.—LAMPERT, 1885 [18], p. 168.—THÉEL, 1886 [46], pp. 97, 149, Pl. V., fig. 6, a-b.—LUDWIG, 1889—'92 [26], p. 347.—SLUITER, 1901 [44], p. 109.

Habitat.—Japan: a single specimen [v. MARENZELLER].

Akashi Strait, “Challenger” Station 233 A. Lat. 34° 38' N., long 135° 1' E., 50 fms., sand: a single specimen (THÉEL).

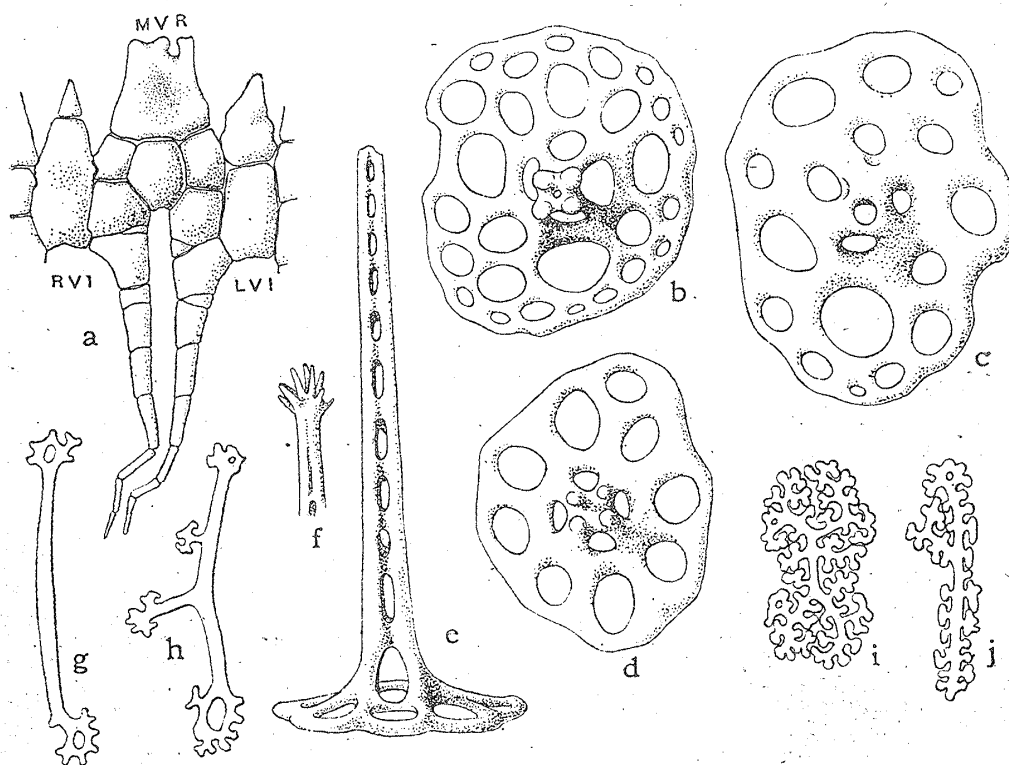
Molo-Strasse, “Siboga” Station 51, 69—91 m., sand with stones and shells: a single specimen (SLUITER).

Southern part of Ōsaka Bay, about 8 fms.: four specimens (K. AOKI coll., Mar. 8, 1903. Sci. Coll., Spec. Nos. 1744—1745).

Size and form.—A specimen, the least contracted, with tentacles partly visible from the outside, is represented in Pl. I., fig. 1. Body cylindrical, slightly curved, broadest in the posterior half; the anal part conically pointed. Length 95 mm., breadth 27 mm. The other three specimens are much contracted and of a spindle-like shape. Length 59, 66 and 70 mm. respectively.

Color.—Dirty grey; contracted parts dark; pedicels whitish.

Integument.—Of varying thickness according to the degree of



Textfig. 7.

*Phyllophorus hypsipyrus* (v. MARENZELLER). *a* Midventral radial segment of the calcareous ring with adjoining interradial segments, abaxial view. *b-d* Tables from general perisome, viewed from above; *e* Same seen from side. *f* Tip of spire from side. *g-h* Supporting rods of tentacle. *i-j* Rosettes from introvert. (*a*  $\times 3$ , *b-j*  $\times 300$ ).

contraction. Its surface rough to the touch, due to the presence of tall-spined tables.

Tentacles.—Twenty in number, of which ten are smaller than the rest.

Pedicels.—Papilla-like, contracted, distributed all over body surface in more or less conspicuous zonal arrangement.

Calcareous deposits.—In general perisome there are found tables only (textfig. 7, b-f). Disk usually of rounded outline with even margin; many-holed ones often elongate. Diameter of disk 0.08—0.17 mm., commonly about 0.12 mm. Holes number 8—36; most commonly 10—15 besides a large central one. Spire stands over the central hole and is very tall, measuring 0.10—0.20 mm. in height; toothed on top (e-f). It consists usually of four pillars united by cross-bars, up to eleven in number. Tables in the anterior body region (b) have in the disk more number of larger holes than those in the middle and posterior regions (c-d). In the introvert, rosettes (i-j) of 0.02—0.08 mm. length alone are profusely found, while at its border with the main body there are found, in addition, some delicate rods in scattered distribution. Pedicels are supported by tables similar to those found in general perisome; only the disk is usually of an elongate and irregular shape, but never of the form described by SLUITER from his specimen as “*zweischenkelige Gebilde mit durchlöcherten Enden*.” End-plates are well developed, exhibiting markedly concave surface on the side facing the end of pedicel; diameter 0.25—0.33 mm., the larger ones belonging to ventral pedicels. Tentacles with delicate bent supporting rods (g-h) 0.04—0.16 mm. long, with both ends branched and giving rise to some holes; often giving off branches in the middle parts also (h). Besides these rods there exist rosettes, which are connected with them by some transitional forms. Around anus there are, besides rosettes and tables, five minute anal teeth, each composed of a stout basketwork. Anal papillæ are supported by delicate branched rods resembling

those found in tentacles.

Calcareous ring.—Composed of small pieces. Radial segment (a, MVR), 19 mm. long and 5 mm. broad, giving off long posterior prolongations consisting of a number of small segments. Interradial segment (RVI and LVI), measuring 5.5—7 mm. in length and 2 mm. in breadth, is usually made up of two pieces.

Retractor muscles.—Inserted to body-wall at a distance less than one-sixth the body-length from the anterior end.

Polian vesicle.—Usually single, hanging in the left dorsal interradius, 11—24 mm. long. In one specimen an accessory vesicle of 5 mm. length was found in the left ventral interradius.

Stone-canal.—4 mm. long, provided with a minute madreporite.

Digestive tube.—Taking the course usual in the subfamily.

Respiratory trees.—Two, one in each dorsal interradius, of a length exceeding five-sixths the body-length.

Genital tubes.—Attached to the mesentery in the same manner as in *Pseudocucumis africanus* and *Phyllophorus cucumiformis* (SEMPER) [LUDWIG 25, p. 813], viz., in two lines of 30 mm. length along the middorsal line. Each tube measures 5 mm. long and is dichotomously branched.

Remarks.—The presence of twenty tentacles made me hesitate somewhat in identifying the specimens at once with *Orcula hypsipyrga*. But I see the tentacle number of that species is still in a very doubtful state. v. MARENZELLER has given it to be fifteen from a much contracted specimen, while THÉEL has found thirteen tentacles, and SLUITER has given no account of the number. A careful re-examination of those specimens in that respect is very much desirable. SLUITER's statement (cited before) with regard to the elongated disk of tables in pedicels does not agree with what I have observed in my specimens, as it probably does not also with the state of the thing in v. MARENZELLER's and THÉEL's specimens. After all, I think my specimens may well be held to be specifically identical with those of

at least the last named two authors, *a fortiori* when we see that Akashi Strait, where the "Challenger" specimen studied by THÉEL had been caught, lies right close to Ōsaka Bay, whence my specimens came.

In conclusion, I beg to tender my sincere thanks to Prof. Dr. I. IJIMA for his kind supervision during the preparation of this paper.

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Tōkyō Imperial University.

December 16, 1911.

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### Explanation of Plate I.

Fig. 1. *Phyllophorus hypsipyrus* (v. MARENZELLER) from Ōsaka Bay. Natural size.

Fig. 2. *Phyllophorus japonicus* (v. MARENZELLER) from Ōsaka Bay. Natural size.

Fig. 3. *Phyllophorus fragilis* MITSUKURI & OHSHIMA, sp. n., from Okinawa, Liū-kiū Islands. Natural size.

Fig. 4. *Pseudocucumis africanus* (SEMPER) from Takanoshima, Awa. Natural size.

Fig. 5. *Amphicyclus japonicus* BELL from Sagami Sea. Natural size.

Fig. 6. Same, probably from Prov. Echizen. Natural size.